Valmet FORWARD

Ensuring tight shut-off and extreme reliability in service

Coating materials for metal-seated ball valves

Mission-critical flow control solutions

Valves are used to secure safety in process plants or to regulate and control process flows in, e.g. pulp mills, steel plants or oil refineries. The important role they play in the productivity and safety of process plants makes them mission-critical. We draw on our long heritage and knowhow to continuously innovate and push forward solutions that redefine how process industries experience reliable flow control performance. Discover the renowned Neles™, Neles Easyflow™, Jamesbury™, Stonel™, Valvcon™ and Flowrox™ products.

Benefits of selecting the right trim coating materials:

- Ensures reliable, even and economical performance
- Reduces trim surface wear and damage
- Helps prevent untimely valve seizure
- Extends valve's operating life and service intervals
- Lower torque allows for use of smaller actuator

The right trim coating helps you avoid:

- Galling of ball-seat contact surfaces
- Surface friction and heat build-up
- Exponential harmful affects of demanding media
- Catastrophic unpredictable valve failure

Coating materials for metal-seated ball valves

Neles™ metal seated ball valves offer superior performance and long lasting tightness over a broad range of services in numerous industries. Every application presents unique challenges that must be considered when determining the most suitable valve for taking your process performance forward.

Many choices are straightforward such as size, pressure class, and body material, but one of the most critical decisions is often the least understood and is sometimes overlooked. Proper selection of trim coating materials is essential to ensure that a valve is configured to meet the demands of the application.

The importance of trim coatings

Metal seated ball valves achieve sealing by metal to metal contact between the ball and seat. When "soft" metals of similar hardness slide against each other under even moderate pressure, galling occurs.

Microscopic protrusions on the seating surfaces catch on each other, resulting in surface friction, heat buildup and plastic deformation. Typically the damage gets worse as the valve cycles until it becomes inoperable due to seizure. If no coatings are applied to the trim, galling will be visible almost as soon as the valve is cycled on the test bench. Once installed in service, the various effects of difficult media would increase wear rate exponentially.

Properly selected coatings reduce the friction between the ball and seats allowing for smooth sliding operation over many numerous cycles, minimizing damage and wear due to galling, abrasion, erosion, particle impact, cavitation and thermal swings. Reducing friction in the trim lowers the valve's operating torque which has several advantages. Lower valve torque allows a smaller actuator to be used which is more economical, results in smaller envelope dimensions of the assembly, improves signal response in control service and simplifies selection of accessories to meet cycle speed targets and other special requirements.

Selection of trim coatings

Valve body, ball and seat materials are selected based on factors such as pressure, temperature and chemical compatibility. These criteria must also be considered when choosing trim coatings. Improper selection can cause almost instant failure of the valve upon startup. It is also important to note that properly selected trim coatings cannot make up for unsuitable base materials.

Most coatings are porous to some degree and do not isolate the base material against the effects of corrosive media. Base material and coating must both be selected to meet the demands of the application.

Overview of coatings, overlays, and surface treatments

Hard chromium (HCr)

Hard chromium is the standard coating for most our valves and is suited to a wide range of applications in liquids and gases at moderate temperatures and pressures. Corrosion resistance of HCr is generally comparable with stainless steels. HCr is not compliant with strong acids like hydrochloric acid (HCl), hydrofluoric acid (HF) or sulfuric acid (H2SO4), and it should not be used with seawater, wet chlorine or other media with high chloride content.

Nickel boron (NiBo)

Nickel boron performs very well in high temperature and high pressure applications. It is resistant to damage from erosion, cavitation and thermal shocks. NiBo is ideal coating for steam service, catalyst handling, slurry services and coal gasification. NiBo has limited corrosion resistance and is not recommended for use with acids and wet chlorine. NiBo coating is available on austenic stainless steels like CF8M (316 SS) balls up to 24" size.

Tungsten carbide (WC-Co)

Tungsten carbide is very resistant to wear from high cycle operations and erosion from abrasive catalysts, muds, slurries and powders. It is ideal for cryogenic applications, oxygen service and non-lubricative dry gas services. WC-Co is not suitable for use in corrosive services and condensates such as water, but generally performs well in hydrocarbon gases and liquids.

Tungsten carbide (TC2)

TC2 has similar hardness and erosion resistance as WC-Co, but it is more corrosion resistant due to alloy binder. Compared to chromium carbide it is harder and better for erosive wear.

Chromium carbide (CrC)

Chromium carbide is well suited to very high temperature gas or liquid applications and has excellent resistance to wear, erosion and corrosive media. It performs well in sour (H2S) hydrocarbon gas, high chloride waters, coal liquefaction, catalyst handling and geothermal brine. Low friction version CrC-LF is applied to seat surfaces to improve sliding performance.

Recommended services to use carbide coatings

- High pressure and temperature services when hard chrome is not useful
- Abrasive and solids handling services
- High cycles services
- Quick valve operation
- When base material and size limitation do not allow use sprayed and fused type coatings
- Limited use in HP steam and HP water in isolation service. Use NiBo and other sprayed and fused type coatings instead

Recommended services to use sprayed and fused NiBo coating

- Medium and high pressure steam
- Boiler feed water service
- High pressure water or condensate
- Abrasive services like
  - Coal gasification/Catalyst handling
- Hydrocarbon gases and liquids
  - High cycle/Thermal cycles

Titanium oxide (TiO_2)

Titanium oxide is a ceramic coating which is mainly used in highly corrosive applications. It is well suited for corrosive pulp bleaching applications. It is also compliant to acidic and erosive slurries encountered in metal extraction processes. In these highly corrosive applications, also the base material must be corrosion resistant.

Cobalt based alloys

We utilize multiple coating materials classified as cobalt base hard facings. Examples include Alloy 6, Alloy 12 and Alloy 50Nb. Specific materials in this class are applied based on their individual properties and suitability for use on different types of valve parts such as seats, plugs, shafts and bearings. Chemical compliance of Co-based alloys is very good and they can be used in similar applications as type 316 stainless steels.

Boriding thermal diffusion process

Boriding is a process in which boron is diffused into the surface of the base material and forms very hard borides onto metal surfaces. Wear and erosion resistance is greatly increased while corrosion resistance is retained or improved. It is well suited to high temperature and abrasive applications and services with demanding material requirements and corrosion concerns. There is no adhesive division point between the surface boride and substrate, resulting in excellent resistance to impact and thermal shocks.

Nitriding thermal diffusion process

Nitriding is a process in which nitrogen atoms are diffused into the surface of ferrous metals like carbon steels or martensitic stainless steels. The nitrogen atoms attach to the chromium, iron, and other alloying elements, which then form hard nitride compounds. The hard nitrided surface is useful in extending the life of a valve bearing surfaces in high temperature and abrasive applications.

Coating application processes

Electroplating

Coatings are electrodeposited from a solution containing the source of the metal to be plated and the required catalysts. This process is used for our standard Hard chromium plating.

S&F: Thermal spray and fuse

These coatings are fused in a furnace or by flame. The size of the part to be coated is limited by the capacity of the furnace. Nickel Boron coating is applied with this method and is available on balls up to 24" size.

HVOF: High velocity thermal spraying

Extremely wear resistant carbide based coatings are applied as a powder combined with a high velocity jet of combustible gases.

Plasma spraying

It's a similar thermal spray coating process as HVOF, but the process gas is in plasma state at very high temperatures in order to melt ceramic powders which are then sprayed onto the surfaces of valve components.

Thermal diffusion

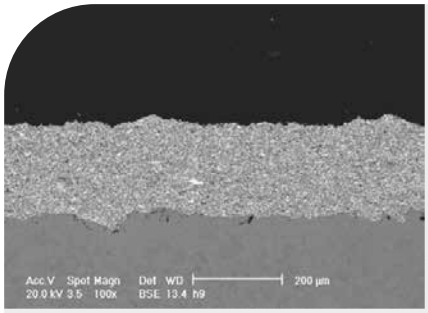
An element is diffused into the material surface to create a dense reaction zone with increased surface hardness and resistance to wear and impact. Corrosion resistance depends on the properties of the base metal.

Plasma transfer arc (PTA)

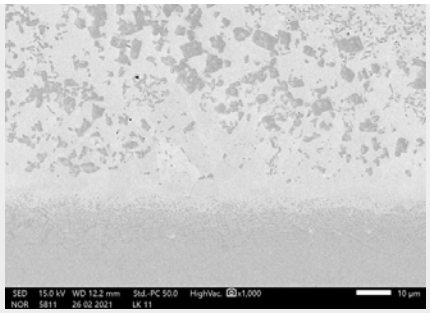
The coating is welded to the substrate using a powder consumable. Plasma arc is generated between electrode and workpiece. PTA cladding produces metallurgically bonded fully dense coatings with a low dilution to the base material. This process is typically used to apply cobalt based alloys for internal parts of valves.

Laser cladding

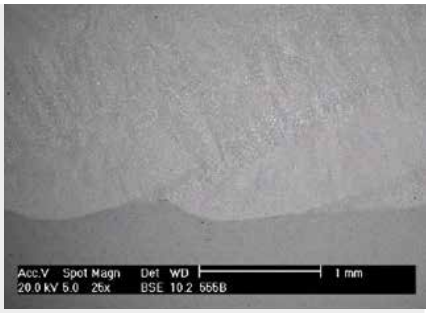
The powder coating material is carried by an inert gas through a powder nozzle into the melt pool. The energy needed is generated by a laser beam. Laser cladding produces metallurgically bonded fully dense coatings with a minimal dilution to the base material. Laser cladding process is typically used to apply cobalt based alloys.



HVOF carbide coating structure



Microstructure of NiBo spray and fuse coating on stainless steel substrate



Cobalt based weld overlay (PTA)

Courtesy of University of Tampere, Finland.

Coating selection and suitability

Coating materials

Coating	Description	Application process
HCr	Hard chromium	Electroplating
NiBo	Nickel boron	Thermal spray and fuse
WC-Co	Tungsten carbide	HVOF
TC2	Tungsten carbide	HVOF
CrC	Chromium carbide	HVOF
TiO_2	Titanium oxide	Plasma spraying
Cobalt base alloy	Alloy 6, Alloy 12, Alloy 50Nb	PTA/Laser
Boriding	Borides	Thermal diffusion
Nitriding	Nitrides	Thermal diffusion

Recommended applications

Ball	Tempera-ture range, ºC	Corrosion resistance	Preferred base material	Erosion resistance	Aqueous media	Quick operations	Dry gas	Typical fluids/ application
HCr	-50 to +450	Good	SS316/CF8M	Good	Yes	Moderate	No	Most widely used, typically pulp and paper and general hydrocarbon services
TC2	-50 to +350	Good	SS316/CF8M	Excellent	Yes	Excellent	Yes	Generic overall applications where HCr cannot be used due to high pressure and mechanical wear
CrC	-200 to +600	Very good	SS316/CF8M	Very good	Yes	Excellent	Yes	Wide application range in hydrocarbon industries where corrosion and wear is encountered. Suitable for higher temperatures than tungsten carbides.
WC-Co	-200 to +450	Moderate	SS316/CF8M	Excellent	No	Excellent	Yes	Oxygen and cryogenic services
NiBo	-50 to +600	Good	SS316/CF8M	Very good	Yes	Good	Yes	MP/HP Steam, feed water, mixed steam and oxygen services
TiO_2	-50 to +300	Excellent	254SMO/ Titanium	Very good	Yes	Good	Yes	ClO2 bleaching, metallurgy processes

Valmet's professionals around the world work close to our customers and are committed to moving our customers' performance forward – every day.

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